Improving Re-Calibrated PERSIANN-CCS for Over High Latitudes and Warm Rain Estimation

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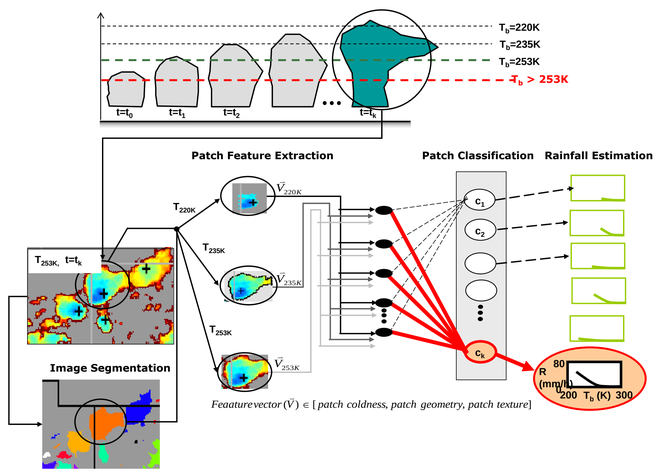
Introduction

Re-calibrated Precipitation Estimation from Remotely Sensed Information using Artificial Neural Network—Cloud Classification System (PERSIANN-CCS) is one of algorithms used in the Integrated Multi-satellite Retrievals for GPM (IMERG) to estimate precipitation for the time period passive microwave precipitation estimation is not available. Modifications had been made on PERSIANN-CCS to improve estimation. Those enhancements include (1) re-calibration of PERSIANN-CCS using multi-satellite passive microwave precipitation and (2) extending estimation to cover warm clouds.

PERSIANN-CCS Estimation

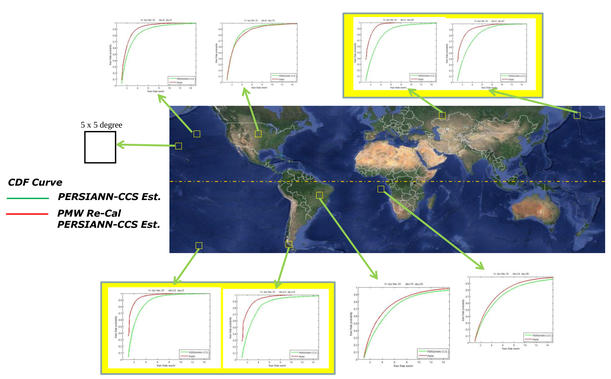
- PERSIANN-CCS is an object-based algorithm that uses cloud coverage areas under defined IR temperature thresholds to estimate rainfall.
- The algorithm uses the longwave IR channel (10.7 μm) to classify cloud images based on the IR brightness temperature segmentation and then extract features for the cloud patches at three levels (220 K, 235 K, and 253 K).
- The rain estimation from PERSIANN-CCS is based on calibrating the cloud top temperature and rainfall (Tb-R) relationships for the classified cloud groups.
- The current PERSIANN-CCS algorithm was re-calibrated using PMW rainfall for the coverage of 60°N to 60°S and 180°W to 180°E.



PMW Re-Calibration of PERSIANN-CCS Estimation

- Probability distribution of Passive Microwave (PMW) Rainfall (MWCOMB, CPC) and PERSIANN-CCS are calculated at each 5°x5° box by each month.
- The Quantile Mapping (QM) method is used to adjust PERRSIANN-CCS toward PMW rainfall distribution.
- It shows PERSIANN-CCS overestimates over high-latitude regions during the winter season (see highlighted boxes in figure).
- Estimates are consistent over the low- & mid- latitudes

PMW and PERSIANN-CCS CDF for each 5°X5° box January (winter time)



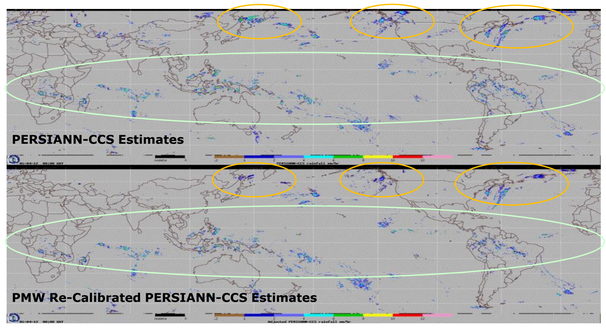
PMW Re-Calibrated PERSIANN-CCS Estimation

- Figures show instantaneous estimates from PERSIANN-CCS (top figure) and PMW re-calibrated PERSIANN-CCS estimation (bottom figure) .
- More corrections were found over the high-latitude regions (see the regions circled in orange color)
- Estimates over the mid- and low-latitudes are not corrected significantly (see the area marked in light green color).

00:30UTC, Jan. 04, 2012

PERSIANN-CCS Precipitation Est. 0.04°x0.04°

PMW Calibrated PERSIANN-CCS Precipitation Est. 0.04°x0.04°

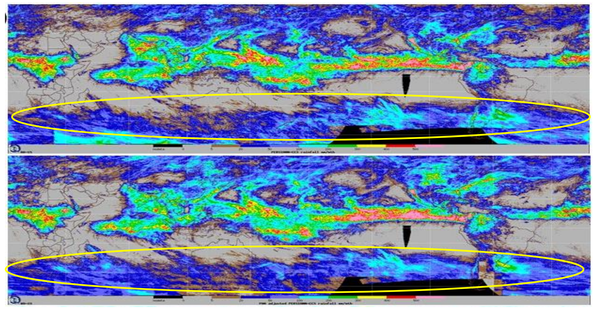


- Monthly rainfall estimates from PERSIANN-CCS and PMW re-calibrated PERSIANN-CCS in July 2015.

July, 2015

PERSIANN-CCS Precipitation Est. 0.04°x0.04°

PMW Calibrated PERSIANN-CCS Precipitation Est. 0.04°x0.04°

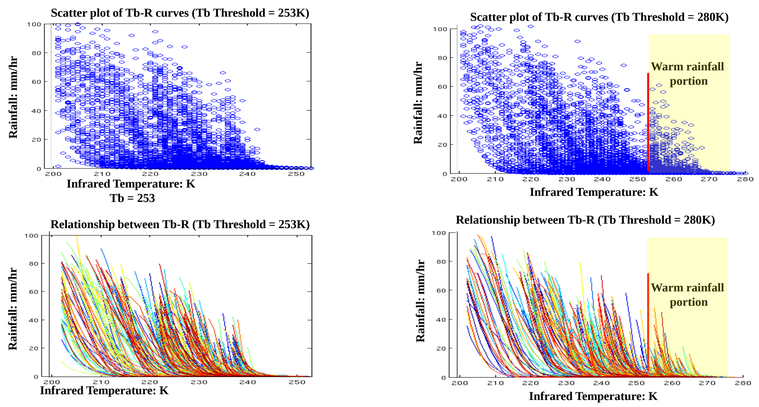


Improving PERSIANN-CCS Estimates for Warm Clouds

- Because the segmentation brightness temperature (Tb) threshold of PERSIANN-CCS was set to 253K, the warm rain clouds (Tb>253K) are not included in the retrieval.
- To get better estimates from warm rain clouds, the cloud segmentation threshold should be extended to warmer temperatures (i.e. Tb > 253K).

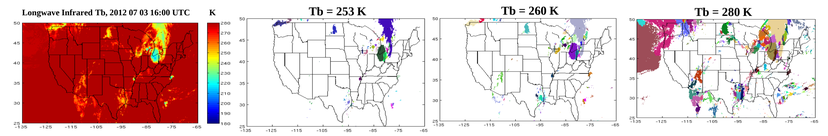
Warm Tb Threshold & Tb-R relationship

- Figures show the classified cloud groups and Tb and rainfall (Tb-R) relationship for the segmentation thresholds at 253K and 280K.
- Tb-R relationship is extended to warmer Tb (see the right hand plots for the parts with Tb>253K)

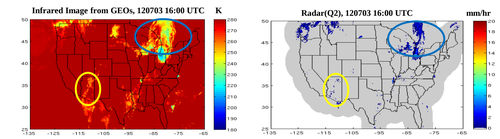


Experiments

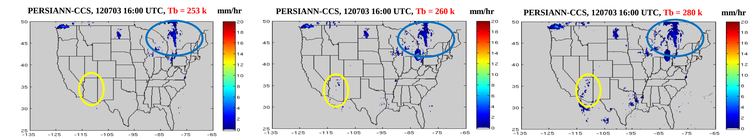
- The example shows how the IR image (16:00 UTC, July 03, 2012) is processed.
- Infrared Tb image and cloud patches from segmentation algorithm using 253K, 260K, and 280K.



- Infrared cloud image compared to rainfall rate from radar measurements

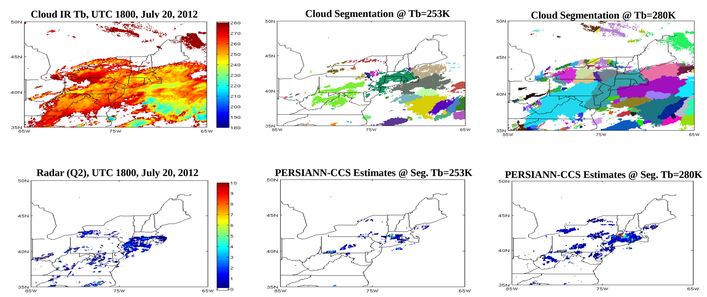


- Precipitation estimation from segmentation thresholds of 253K, 260K, and 280K.
- Warm rains over Arizona are better detected with the Tb=280K threshold.



Segmentation Threshold = 253 K: # of rainfall pixels captured = 7922 pixels
Segmentation Threshold = 280 K: # of rainfall pixels captured = 12405 pixels
# of rainfall captured specifically from warm clouds: (Tb > 253 K) = 1084 pixels

- The example below shows an instantaneous image (18:00 UTC, July 20, 2012). Segmentation thresholds are set to Tb=253K & 280K, respectively.
- Comparing to radar estimation (Q2), rain detection is improved using Tb=280K.



Conclusion

- PMW Re-calibrated PERSIANN-CCS estimation is integrated in the estimation of IMERG precipitation for the time period when PMW precipitation is not available. Providing effective adjustment of PERSIANN-CCS estimation toward PMW precipitation estimation is essential.
- Re-calibration of PERSIANN-CCS using PMW rainfall estimation. PERSIANN-CCS rainfall over high-latitude regions are adjusted toward PMW rainfall distribution. No significant adjustments were made over the mid- and low-latitude regions.
- The effect of setting the PERSIANN-CCS IR cloud image segmentation Tb threshold at 253K meant warm raining clouds were not covered in the rain retrieval (i.e. set to no rain), our experiments show increasing the segmentation Tb threshold (e.g. 280K) can provide improved rain detection and estimation.

Acknowledgements

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